CFD simulation of nanofiber-enhanced air filter media

FILTECH

February 24 – 26, 2015
Cologne – Germany

The Filtration Event
www.Filtech.de

Abstract Book

February 24 – 26, 2015
Koelnmesse
Cologne · Germany

International Conference & Exhibition for Filtration and Separation Technology

FILTECH 2015

FILTECH 2015

Abstract Book

CONTENT

Conference Dates:
February 24 – 26, 2015

Venue:
Koelnmesse · Deutz-Mülheimer-Str. 35 · 50679 Cologne · Germany

Organizer:

Filtech Exhibitions Germany GmbH & Co KG
PO Box 1225 · 40637 Meerbusch – Germany
phone: +49 (0) 2132 93 57 60
fax: +49 (0) 2132 93 57 62
e-mail: Info@Filtech.de
web: www.Filtech.de

Abstract Book ISBN-13: 978-3-941655-09-6
USB-Stick ISBN-13: 978-3-941655-10-2

SCIENTIFIC COMMITTEE CHAIRMEN

- **Dr. Harald Anlauf,** Karlsruhe Institute of Technology (KIT) · Germany
  Institute for Mechanical Process Engineering and Applied Mechanics
- **Prof. Eberhard Schmidt,** University of Wuppertal, Germany
  Department Safety Technology / Environmental Protection

SCIENTIFIC COMMITTEE

Prof. Mônica Lopes Aguiar	São Carlos	Brazil
Dr. Harald Banzhaf	Ludwigsburg	Germany
Dr. Krishna Gupta	Ithaca	USA
Prof. Antti Häkkinen	Lappeenranta	Finland
Prof. Wilhelm Höflinger	Vienna	Austria
Prof. Kuo-Jen Hwang	Taipei	Taiwan
Prof. Eiji Iritan	Nagoya	Japan
Prof. Chikao Kanaoka	Tsubata	Japan
Prof. Gerhard Kasper	Karlsruhe	Germany
Dr. Karsten Keller	St. Louis	USA
Ir. Hermanes Kleizen	Hengelo	Netherlands
Prof. Gernot Krammer	Graz	Austria
Dr. Martin Lehmann	Ludwigsburg	Germany
Prof. Markus Lehner	Leoben	Austria
Prof. Dietmar Lerche	Berlin	Germany
Prof. Woon-Fong Wallace Leung	Hong Kong	P.R. China
Dr. Hisao Makino	Yokosuka	apan
Prof. Gerd Mauschitz	Vienna	Austria
Prof. Arunangshu Mukhopadhyay	Jalandhar	India
Prof. Marja Oja	Hut	Finland
Dr. Thomas Peters	Neuss	Germany
Dr. Christophe Peuchot	Foulayronnes	France
Prof. Urs Peuker	Freiberg	Germany
Dr. Jaroslav Pridal	Hradec Krawlve	Czech Republic
Dr. Graham Rideal	Waverton	UK
Prof. Siegfried Ripperger	Kaiserslautern	Germany
Prof. Peter Scales	Parkville	Australia
Prof. Hans-Joachim Schmid	Paderborn	Germany
Dr. Anthony Stickland	Melbourne	Australia
Prof. Hans Theliander	Gothenburg	weden
Prof. Bhaskar N. Thorat	Mumbai	India
Prof. Paolo Tronville	Torino	Italy
Prof. Kuo-Lun Tung	Taipei	Taiwan
Prof. Eugène Vorobiev	Compiègne	France
Dr. Matthias Waldenmaier	Kaiserslautern	Germany
Yan-Xi Wang	Shangha	P.R. China
Prof. Takeshi Yoneda	Kuwana	Japan

The Committee list lists countries and regions

PAGE INDICATOR AND SESSION CHAIRMEN

TUESDAY, FEBRUARY 24, 2015

WEDNESDAY, FEBRUARY 25, 2015

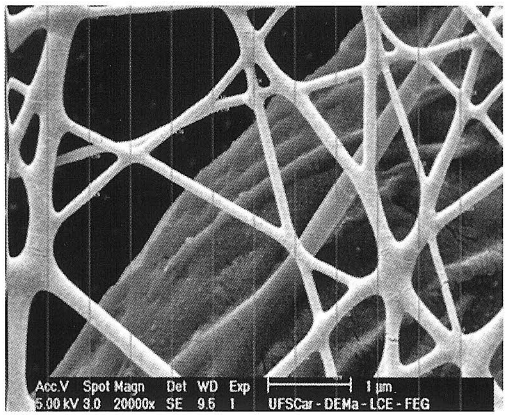
THURSDAY, FEBRUARY 26, 2015

CFD SIMULATION OF NANOFIBER-ENHANCED AIR FILTER MEDIA

Paolo Tronville*, Politecnico di Torino, Corso degli Abruzzi 24, 10129 Torino - Italy;
L.L.X. Augusto, A.C.C. Bortolassi, G.C Lopes, J.A.S Gonçalves,
Universidade Federal de São Carlos, São Carlos, Brazil;
R.D. Rivers, EQS Inc., Louisville, Kentucky 40204 USA

ABSTRACT

The first step in a CFD analysis of filter media flow is to create a computational domain geometry which imitates the simulated media as closely as is practical. The media in the present study combined a relatively flat web of nanofibers with a cellulosic fiber support media. Fig. 1, a SEM image of the material at 1000x, shows the highly random nature of the two media elements, and the difference in scale between them. Fig. 2 is a 20000x SEM image of the same media, showing the polymeric nanofiber web, and behind it, a single cellulosic fiber having a diameter perhaps 100 times the diameter of the nanofiber web elements. A CFD grid suited to calculating the flow patterns through the cellulosic media structure would be far too coarse to simulate flow around the nanofiber web elements. This scale difference forces some assumption about the interaction between the media layers. Our models are limited to two dimensions, representing cross-sections cut through the media



in the direction perpendicular to figures 1 and 2. Our initial studies modeled the nanofiber web alone, on the assumption that the flow around the nanofibers is not greatly influenced by the presence of the downstream cellulosic fibers. It is apparent from Fig. 2 that not all parts of the nanofiber web have circular cross-sections. Our image-analysis technique samples the distribution of fiber diameters by scribing parallel lines across the image (faintly visible here). The diameter of the web element at each line/fiber crossing is tabulated. An estimate is made of the maximum width on the image for which the web element cross-section can be considered circular. We make the assumption that the relatively flat web elements linking round sections have oval cross-sections, all of the same thickness. We found that the distribution of web element widths is "doubly-truncated log-normal", meaning that both lower and upper limits to the widths exist. This geometry was used with a CFD code to calculate particle capture, and compared to results of tests on the actual media.

KEYWORDS

CFD, Nanofiber, Cellulose Fibers, Fiber Size Distribution, Flow simulation